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Schedule

2001 Graduate Student Technical Conference
Masters Presentations

Friday, April 20, 2001
Adamson Wing, Baker Hall 136A

8:00 a.m.		**Opening Breakfast**
8:45	Gabriel Aguirre Ollinger	RedesignIT -- A Constraint-Based Tool for Manag
9:05	Mohammed Alrasheed	Effect of Conductivity Enhancers in Phase Change
9:25	Eric Lipsky	Effect of Sampling Conditions on Primary Particula Combustor
9:45	Tolga Kurtoglu	Interpreting Sketches of Mechanical Devices Usin
10:05		**Break**
10:25	Jeff Beisheim	A Comparison of Submodeling and Adaptive Grid
10:45	Chandankumar Aladahalli	Using Geometric Sensitivity Analysis to Infer Timin 3D Layout Algorithm
11:05	Elie Shammas	Hyper-Redundant Robots, History and Developme
11:30		**Lunch - Scaife Hall 322**
12:30		**Poster Presentation - Scaife Hall 301**
1:15	Saurabh Deshpande	An Agent Based Optimization Approach to Manufa
1:35	Quan Ding	Automated Trunk Pacing With Extended Pattern S
1:55	Hadas Shragai	High Bandwidth Control for Optical and Magneto-C
2:15	Mark Bedillion	Dynamics and Control Under Slip and No-Slip Con
2:35		**Break**
2:55	Doug Hull	Tethered Robot Path Planning Using Wavefront Tc
3:15	Vinit Srivastava	Feature Extraction
3:35	Huang Tang	Effects of Normal Stress on the Failure of Titanium

3:55	Tian Zhou	An Angle-Based Approach to Two-Dimensional Me
4:30 - 6:00		**Awards Reception - Scaife Hall 322**

Online Proceedings

To obtain more information about a research project, contact the faculty advisor of the student author.

RedesignIT -- A Constraint-Based Tool for Managing Design Changes

Gabriel Aguirre Ollinger

Abstract:

RedesignIT is a computer program that uses model-based reasoning to generate and evaluate proposals o redesign plans for engineered devices. These proposals describe how the design parameters could be changed to achieve a specified performance goal. Equally important, the program proposes complementar modifications that may be necessary to counteract the undesirable side effects of the primary changes. RedesignIT is intended for use during the first stages of a redesign project, when engineers need to make a quick, yet accurate assessment of the overall effects of a particular design change. The program uses qualitative device models, which allow it to compute redesign plans efficiently. With its ability to predict the collateral, and probably undesirable, effects of a design change, the program is well suited to aid product designers in deciding on the feasibility of introducing design changes to a product. RedesignIT employs methods of artificial intelligence, especially qualitative reasoning, causal influence graphs, and heuristic search.

Advisor: Tom Stahovich

Effect of Conductivity Enhancers in Phase Change Thermal Storage Devices

Mohammed Alrasheed

Abstract:

This paper is divided into two parts. The first part presents a review on Phase Change Materials (PCMs) characteristics as a mean of latent heat storage techniques. In addition it compares two commonly used PCMs (Paraffins, Salt hydrates) including their drawbacks. The second part studies a Thermal Control Unit (TCU) in portable electronic devices such as cellular phones, personal digital assistants (PDAs) and laptop computers to improve energy management, by using passive cooling strategy, e.g., latent heat storage technique. Three types of TCU are investigated. The first type of TCU is made of an organic PCM, the second type of TCU is made of PCM and conductivity enhancer, composed of aluminum foam, and the third type of TCU when it is made of PCM and conductivity enhancer, composed of aluminum fins (strips).

Effect of Sampling Conditions on Primary Particulate Matter Emission From a Pilot-Scale Coal Combustor

Eric Lipsky

Abstract:

A dilution sampler has been designed and manufactured to simulate the effects of the dilution process on particulate matter emissions from coal-fired power plants and other combustion systems. The sampler design allows independent control of the dilution ratio and residence time. Experiments were performed to characterize the sampler: we characterized the mixing rate of the sampled exhaust with dilution air, and characterized the residence time of the system. Experiments were then performed to examine particulate emissions of a pilot-scale coal combustor burning a low sulfur bituminous coal. Measurements of exhaust particle number concentrations and size distributions were made as a function of residence time and dilution ratio. A nucleation peak was measured at around 0.01 microns. This peak was found to increase with increased dilution ratios, and to decrease with increased residence times. These changes are explained with coagulation theory. We also observed a 0.1 mm peak. Filter samples were collected to measure mass emission rates and obtain speciation data.

Advisor: Allen Robinson

Interpreting Sketches of Mechanical Devices Using Physical and Behavioral Reasoning

Tolga Kurtoglu

Abstract:

This paper introduces a tool that uses physical and behavioral reasoning to interpret schematic sketches of mechanical devices. The program takes freehand sketches of physical devices as input. It recognizes each component in the schematic sketch and understands their physical meaning within the context of the sketch by using geometric and physics-based reasoning techniques. "Qualitative Behavior Models (QBM's)", describing energy flow through components, are then used to simulate component behaviors. A textual description of the overall device behavior is then created using this simulation.

Advisor: Tom Stahovich

A Comparison of Submodeling and Adaptive Grid Refinement for the Analysis of Stress Concentrations

Jeff Beisheim

Abstract:

Efficiently and accurately computing the stresses associated with stress concentrations is important in engineering analysis. Submodeling and adaptive grid refinement are two procedures available to do this. With submodeling, a subregion is broken out from the original global region and analyzed separately. This subregion requires boundary conditions taken from the analysis of the global region. Accurately estimating the errors associated with these boundary conditions is critical to controlling them and thereby enabling

efficient submodeling. In this paper we describe a procedure for being reasonably certain these boundary condition errors are estimated accurately. Some two-dimensional test problems are used to demonstrate the submodeling procedure. These test problems are also analyzed with an adaptive-grid-refinement scheme. A low-order and a higher-order element are used with both approaches. From the results, a comparison is then made between the two procedures. This shows that the two are of comparable efficiency for moderate stress concentrations, but that submodeling is more efficient for unusually high stress concentrations.

Advisor: Glenn Sinclair

Using Geometric Sensitivity Analysis to Infer Timing Schedule of Move Sets for a Pattern Search Based 3D Layout Algorithm

Chandankumar Aladahalli

Abstract:

The extended pattern search algorithm has proven to be effective for 3D product layout, but it has not been subject to rigorous analysis like its counterpart, simulated annealing in the circuit layout world. A variety of parameters in extended pattern search still need to be tuned manually. This paper introduces guidelines for the tuning of one such parameter, namely the timing schedule of the move sets. The concept of sensitivity of the objective function to different move sets is presented and is used to schedule the move sets. Our hypothesis is to apply moves in the decreasing order of the sensitivity of the objective function on them. The algorithm applying move sets according to this guideline showed an improvement of more than 30% in the objective function compared to the previous algorithm.

Advisor: Jonathan Cagan

Hyper-Redundant Robots, History and Development

Elie Shammas

Abstract:

This paper will present the history and development of hyper-redundant robots, commonly termed snake robots due to similarities in structure and motion between these robots and biological snakes. What is particular about these robots is that they locomote using non-conventional methods such as wheels and legged motion. Wheels are the earliest tools developed by mankind to facilitate transportation. Wheels are very efficient in open flat spaces but they have a constantly rotating element which makes sealing the machine from the harsh outside environment a big challenge. Moreover, wheeled locomotion is highly inefficient or useless in case of non-flat terrains. The other conventional mode of locomotion legged motion has been researched and studied for a long time, but until now scientists are hindered by complex control and balance problems to maintain stability and induce smooth motion onto the robot. On the other hand, snake locomotion has always been considered as a mysterious phenomenon and it was not until recently with the development of sciences like bio-mechanics that scientists were able to perform analytical research on snake motion. After understanding some basic theory on how biological snakes locomote, scientists are building snakelike robots and trying to implement various modes of locomotion onto these robots. This paper will present our contribution to snake robot design and our advances in snake locomotion.

Advisor: Howie Choset

An Agent Based Optimization Approach to Manufacturing Process Planning

Saurabh Deshpande

Abstract:

Many design optimization problems, such as manufacturing process planning optimization, are difficult problems due to the large number of potential configurations (process sequences) and associated (process) parameters. In addition, the search space is highly discontinuous and multi-modal. Previous approaches to this problem fall under the class of hill climbing algorithms viz. simulated annealing, Monte Carlo search and Tabu search. This paper presents an alternative approach using agents. The agent basec optimization algorithm combines stochastic optimization techniques with knowledge based search. The motivation is that such a merging takes advantage of the benefits of stochastic optimization and accelerates the search process using domain knowledge. The result of applying this algorithm to computerized manufacturing process models is presented.

Advisor: Jonathan Cagan

Automated Trunk Packing With Extended Pattern Search

Quan Ding

Abstract:

Automobile trunk packing is an instantiation of the general 3D product layout problem. The problem is difficult to solve because of the multi-modal and discontinuous characteristics of the layout space configuration. In this work, the extended pattern search algorithm is chosen as the optimization technique because it converges faster than other more stochastic algorithms like genetic algorithm and simulated annealing algorithm. Further, its properties are such that it is less likely to get trapped in local optima than deterministic gradient-based algorithms. The trunk packing problem has unique special properties: First it requires very tight packing. Second, based on SAE specifications, a subset of potential components must be selected to optimize trunk space usage without having component overlap. To address these properties and create a time-efficient algorithm, a number of extensions were made to the basic technology.

Advisor: Jonathan Cagan

High Bandwidth Control for Optical and Magneto-Optic Disk Drives

Hadas Shragai

Abstract:

The Electrooptic Beam Scanner is a solid-state device developed at Carnegie Mellon's Data Storage Systems Center (DSSC) that is capable of scanning a laser beam approximately ±1-3° at frequencies of at least 200 kHz. The Scanner is currently being employed as a fine actuator in parallel with a voice coil motor (VCM) for high performance optical data storage systems. The addition of the Scanner greatly reduces settling times of the tracking system and makes extremely fast short seeks possible. This paper discusses several aspects of that research, including multi-track scanning for increased data rate, controller design for two stage actuator systems, and the Sbode method and adaptive feedforward cancellation techniques.

Advisor: William Messner

Dynamics and Control Under Slip and No-Slip Contact for the Modular Distributed Manipulator System

Mark Bedillion

Abstract:

The Modular Distributed Manipulator System (MDMS) is an array of actuators that is capable of manipulating objects in the plane. This paper examines object dynamics under two contact modes between actuator and object: viscous and no-slip. Each actuator in the array consists of two closely spaced, orthogonally mounted motorized roller wheels whose combined action approximates a programmable vector force. Dynamics under a viscous friction assumption are derived for transported objects by explicitly considering the two traction forces from each wheel of the actuator and supporting simulation results are provided. This contrasts with prior work, which assumed an ideal single point of contact for each actuator. Seemingly anomalous misalignment of objects observed on the prototype system is explained when actuator discreteness is taken into account. This paper then derives equations of motion for the coupled dynamics of the MDMS actuators and objects riding upon it while considering traction forces generated by no-slip rolling contact. This approach allows more precise manipulation, because object positions and orientations and their time derivatives can be determined by wheel encoder information. This paper then presents two different feedforward control strategies based on minimizing the sum of the squares of the inputs or minimizing the total system power and discusses conditions under which no-slip contact is guaranteed.

Advisor: William Messner

Tethered Robot Path Planning Using Wavefront Topological Planner

Doug Hull

Abstract:

Path planning for a tethered robot in a planar environment provides more challenges than conventional untethered planning. The tether path is history-dependent, i.e. going one way around any given obstacle instead of the other will limit the paths that can be used to get to future locations. We introduce the wavefront topology planner (WAFT), a method of partitioning the configuration space of a tethered robot using only work space information. The configuration space for a tethered robot can be envisioned as having "flaps" that wrap around obstacles. While points on different flaps may map to the same work space points, traveling from one flap to another can not be done directly. We introduce a construction method that directly produces the cellular decomposition in work space. WAFT arranges these partitions into an adjacency graph, specifically a tree structure. Path planning is thus reduced to a graph search. WAFT has the added benefit of partitioning the configuration space which affords a concise representation of all paths in configuration space. We intend to extend this method for serpentine robots by modeling the tether as piecewise linear.

Advisor: Howie Choset

Feature Extraction

Vinit Srivastava

Abstract:

Geometric models of solids often contain features like notches, blind holes, through holes, bumps, slots, etc., that we often would like to isolate and remove. Feature removal could be desirable for many reasons including simpler finite element meshing and analysis of feature purpose. In this work we present an algorithm that takes in a solid model of a polyhedral solid and outputs the solid models of the features of the model and the model without the feature. The program has a feature ranking system that takes in inputs of good and bad features from an end user, learns a ranking criteria and applies it to rank potential features. Such a ranking scheme could permit a higher level software to quickly determine the top features of a solid for defeaturing or analysis of feature purpose. This approach to feature removal is more general than any of the existing methods.

Advisor: Tom Stahovich

Effects of Normal Stress on the Failure of Titanium Aluminides

Huang Tang

Abstract:

Titanium aluminides are candidates for replacing nickel superalloys in some aircraft engine components. In uniaxial tension tests, they experience plastic strains at failure that place them in-between traditional definitions for ductile and brittle materials. This study considers the appropriate continuum mechanics failure criterion for these materials under multiaxial loading conditions. In particular, the role of normal stress in determining plastic strains to cause failure is considered. The material tested has a predominantly lamellar microstructure with approximately 25 vol. % equiaxed gamma grains. Results from two groups of tests are presented. In the first group, unnotched cylindrical specimens are loaded in torsion, tension and sequentially in torsion and tension to gain insight into failure due to various combinations of normal stress and plastic strain. In the second group of tests, notched cylindrical specimens are tested in tension to quantify reductions in failure loads due to elevated normal stress ahead of the notch root, compared to failure loads predicted by a maximum equivalent plastic strain criterion. To properly interpret the experimental results, the effects of notch strengthening must be included in the model predictions. Results of all tests indicate that this TiAl alloy has some sensitivity to normal stress and that a combined failure criterion is needed to accurately predict failure under multiaxial loading conditions. A fracture initiation and failure mechanism requiring a combination of normal stress and plastic straining is suggested that is consistent with features observed at notched specimen fracture initiation sites.

Advisor: Jack Beuth

An Angle-Based Approach to Two-Dimensional Mesh Smoothing

Tian Zhou

Abstract:

We present an effective and easy-to-implement angle-based smoothing scheme for triangular, quadrilateral and tri-quad mixed meshes. For each mesh node our algorithm compares all the pairs of adjacent angles incident to the node and adjusts these angles so that they become equal in the case of a triangular mesh and a quadrilateral mesh, or they form the ideal ratio in the case of a tri-quad mixed mesh. The size and shape quality of the mesh after this smoothing algorithm is much better than that after Laplacian smoothing. The proposed method is superior to Laplacian smoothing by reducing the risk of generating inverted elements and increasing the uniformity of element sizes. The computational cost of our smoothing method is yet much lower than optimization-based smoothing. To prove the effectiveness of this algorithm, we

compared errors in approximating a given analytical surface by a set of bi-linear patches corresponding to mesh with Laplacian smoothing and a mesh with the proposed smoothing method. The experiments show that a mesh smoothed with our method has roughly 20% less approximation error.

Advisor: Kenji Shimada